

ON A DISTINCTIVE NEW SUBEQUATORIAL AUSTRALIAN QUADRANNULATE LAND-LEECH, AND RELATED MATTERS

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(Figures 1, 2)

Abstract:

The elaboration of organs on the anterior end of the paired male ducts within the median longitudinal chamber, the absence of a vagina and the presence of an oviducal glandular sac, are shown as a typical haemadipsoid reproductive system. *Nesophilaemon* is shown to differ markedly from the haemadipsoids. Blanchard's *minutus* and *grandidieri* are removed from *Philaemon*. *Neoterrabdella australis*, n.g., n.sp. has 2 jaws; viii to xxiii complete ($a_1/a_2/b_5/b_6$ —total 16); xxiv, 3-annulate; 6 or 7 annuli margining the auricles; lambertian organs absent.

Because of the inadequacies in the systematics of the land-leeches, before a description of a new leech from the vicinity of Darwin can be undertaken, it is first necessary to demonstrate the distinctive nature of the regional morphology of the anterior portion of the paired male ducts in the land-leeches; as also of the morphogenesis and organization of the median region of the female system and to provide a distinctive terminology for this; to consider the nature of the g.*Philaemon* and its content, as also matters concerning other 4-annulate genera.

The 4-annulate land-leeches have been known as a small group with a peculiar distribution. Although Lambert (1898) provided a fully detailed account of the 2-jawed 4-annulate *Philaemon pungens*, the type of the genus, Blanchard did not utilize this information in his monograph of the Haemadipsinae (1917) where he concerns himself only with external metamerism and places all 4-annulates in the g.*Philaemon*. The inadequacy of this simple systematics was demonstrated in the discovery by Moore (1938) of *Tritetrabdella*, a 3-jawed 4-annulate land-leech in Malaya. Blanchard handled material from eastern Australia and Java, all of which he considered to be *P. pungens*, and described *P. minutus* from the Samoan Islands and *P. grandidieri* from Madagascar. Johansson (1924) described a 2-jawed 4-annulate from Juan Fernandez, placing this in the g.*Philaemon*. Ringuet (1955) gives a detailed account of this species and provided a new genus, *Nesophilaemon*, for it. In his invaluable key to the genera and catalogue of the species of the haemadipsid leeches, Soos (1967) recognised 9 genera and 24 species. He gives a brief diagnosis of the g.*Philaemon* giving the annulation of complete somites as $b_1/b_2/a_2/a_3$, a_1 being subdivided as is the condition found by Ringuet in *Nesophilaemon*. This does not agree with Lambert nor with the annulation I have so far seen in the Australian 4-annulates. Soos recognises in *Philaemon* the three species in Blanchard, and *P. grandis* Ingram 1957 which is closely and fully described.

The haemadipsoid reproductive system (Figs. 1B, F.)

Details of the reproductive system in land-leeches were first given by Whitman (1886) in his account of *Haemadipsa japonica*. Others have been described since then; but the complete contrast between the reproductive systems in the aquatic arhynchobdellids and the land-leeches has never been demonstrated as distinctively haemadipsoid and without parallel in the hirudinoids.

Lambert (1898) gave an intimately detailed account of the male and female systems in *Philaemon pungens*, and (1899) describes the systems in

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two species of *Chtonobdella* as being similar to *pungens*; Harding (1913), in *Idiobdella*; Moore (1927), in several Asian species of the *g.Haemadipsa*, in 1938 in a Malayan species of *Tritetrabdella* and a species of *Phytobdella*, and 1944 in two further species of *Phytobdella* from New Guinea; Ingram (1957) in close detail for *Philaemon grandis*; and Ringuet (1955) in *Nesophilaemon*. There are some other accounts but not fully assessable with confidence. In addition to *Chtonobdella*, I have knowledge from the dissection of three other species of 5-annulates of a second genus, and a variety of species of Australian 4-annulates as well as the new genus described below. From the above, we have knowledge of the reproductive systems in 3-jawed 4- and 5-annulate leeches, and 2-jawed 4-, 5-, and 6-annulate leeches. With the single exception of *Nesophilaemon*, which is dealt with separately later in this paper, the systems are closely similar in all, in both morphogenesis and organization, and in regional morphology.

In the hirudinoids (Richardson, 1969) I have shown that the organs on the anterior portions of the paired male ducts elaborate within the paramedian longitudinal chambers of the body cavity, lateral to the paramedian palisade of the dorsoventral muscle system and accordingly lateral to the crop. There are five distinctive patterns. There is only the one pattern in the haemadipsoids. The vas deferens runs anteriorly in the paramedian chamber in the haemadipsoid, the same as in the hirudinoids, but a primary reflected simple loop forms on each of the male paired ducts within the median chamber, extending ventral to the crop. The epididymis elaborates on the recurrent limb, and the thin-walled sperm-duct on the procurvent limb which terminates in a minute ejaculatory bulb lacking in *Philaemon* and *Idiobdella*.

As seen in the dissection of small specimens of 4- and 5-annulates (9.0 to 13.00 mm. in length), in initial morphological and functional development, the right and left loops lie side by side and are parallel in the median chamber. In later growth and functional differentiation, the initial and terminal portions of one loop elongate so that there is a greater length of vas deferens on this loop and the epididymis and the coiling portion of the sperm-duct become located posteriorly, even extended dorsal to the female median region, and there is a length of straight sperm-duct connecting to the median region. In this way the epididymis and coiling sperm duct of the one side become located posteriorly to the organs on the other loop in which the portion of vas deferens in the median chamber remains short, and the sperm duct remains short but is much coiled even close to the bulb. The two sets of organs now lie in tandem.

The sequence of vas deferens, epididymis, and sperm duct without an ejaculatory bulb is seen in various hirudinoid genera (*Aetheobdella*, *Macrobdella*, some species of '*Limnatis*') and with a bulb in *Ornithobdella*. There is here a similarity in the level of organization on the male paired ducts in hirudinoids and haemadipsoids; but the regional morphology of the organs on the male paired ducts in the haemadipsoids is seen nowhere in the hirudinoids. The central positioning of these organs in the median chamber and the tandem arrangement which extends them along more somites than in the typical amyomeric mesomorphic jawed aquatic is recognisable as functionally advantageous to a terrestrial animal which must maintain balance and move in an environment which does not give passive overall support to the body such as does the aquatic environment. The functional demands placed on the muscular body wall envelope of the land-leech are most clearly expressed in the maintenance of the erect extended posture over considerable periods.

The male median region in all consists of a small weakly muscular atrium ending in a bursa opening at the genital pore. I have seen a minute and short briefly conical penis in several, a penis similar to that in the ornithobdellids *Aetheobdella* and *Ornithobdella*, hirudinoids which are both amyomeric, micromorphic in the form of the median male region as is the condition in the haemadipsoids.

In the new leech described here and in *Idiobdella*, the ovaries are simple tubular, briefly folded; simple sac-like in all others. The oviducts are short, not markedly longer than the ovaries, thin-walled as in the hirudinoids, and in the haemadipsoids join without the formation of an obvious atrial chamber such as is characteristic in the hirudinoids.

The regional morphology of the hirudinoid and haemadipsoid female median regions is the same. Both are myomeric, with an elongate muscularised region between the junction of the oviducts and the bursa. This is mesomorphic in the haemadipsoids, the junction of the oviducts remaining in the original position; but the morphogenesis and organization of this region in the haemadipsoids is entirely distinct.

The female median region in both develops in the median longitudinal chamber as a posteriorly directed loop, formed at a locus of growth between the junction of the oviducts and the bursa. The loop is ventral to the crop and lies initially in the horizontal plane. The recurrent limb of the loop is initially thin-walled but in the haemadipsoids it becomes moderately muscular in differentiation (Ingram, 1957, reports well-developed circular muscles), and the lumen is relatively reduced. This contrasts with the recurrent limb (common oviduct) in the hirudinoids which is never invaded by muscularization and remains always thin-walled with a relatively large lumen. In the haemadipsoid, the procurent limb extending from the elbow of the loop anteriorly to the bursa becomes strongly muscular with a greatly reduced lumen. In this way, it resembles the vaginal duct of the hirudinoid.

The two limbs are parallel, closely approximated, and invested with a common connective tissue. The posterior face of the elbow expands posteriorly in morphological differentiation to form a weakly muscled sac lined with a thick glandular epithelium which as seen in small specimens (Fig. 1, F.) is initially thicker than the supporting tissue of the wall of the sac. Through this morphogenesis, the two limbs of the primary loop open without valves and in immediate proximity to one another on the anterior face of the sac, initially centrally, later ventrally following secondary expansion of the sac on the oviducal side. The area surrounding the entry of the two limbs becomes more strongly muscular than the general wall of the sac.

The asymmetrical growth of the sac is associated with torsion of the sac on the axis of the procurent limb, the torsion extending somewhat along the two limbs so that the recurrent limb lies more or less above the procurent limb. I have noted in some dissections that there is a compact half-loop on the end of the recurrent limb immediately at the attachment to the sac, a development clearly related to the process of torsion for both limbs are intimately bound together along their length.

The female median region of the haemadipsoid is without parallel in the hirudinoids. In the hirudinoids with the myomeric condition, muscularization spreads along the procurent limb but never onto the recurrent limb. The procurent limb differentiates as the strongly muscular vagina (and vaginal duct). The recurrent limb enters this terminally in the caecates. In the caecates, the caecum forms by growth of the muscular vagina beyond the point of connection to the recurrent limb. This caecum is lined with epithelium of the same nature as the body of the vagina.

The glandular sac of the haemadipsoid can in no way be assessed as morphologically an equivalent of the vagina or vaginal caecum in the hirudinoid. To apply to it such terms as vagina, vaginal sac, and to refer to a vaginal duct is misleading, confusing, and obscures the distinctive nature of the organization in this region of the reproductive system of the haemadipsoids.

The prostate glands so far as I have seen them in the haemadipsoids are finer in texture, less compact, more deeply subdivided and a larger mass

than in the myomeric hirudinoids; but they are similar to the glands as seen in the amyomeric hirudinoids (*Aetheobdella*, etc.).

I have seen no indications of albumen glands in the haemadipsoids, nor have I seen them reported in other accounts.

The g. *Philaemon*.

It is most exceptional in the jawed leeches to have a genus provided before 1900 based on a species intimately described externally and internally at the time the genus was established. Lambert (1898) gives a complete and precise account of *Philaemon pungens* as the type of this genus, the first such description of a land-leech and without equal until Moore (1927). To Lambert's account can be added Ingram's (1957) excellent description of *Philaemon grandis* and a briefer account of *pungens*. The two species are clearly congeneric and allow of a description of the g. *Philaemon* adequate for the present occasion.

Blanchard (1917) defines the g. *Philaemon* only as 4-annulate, gives only the external meristic morphology of *pungens*, figures a leech which he considers to be this species, and describes and figures the external meristic characters of two other species which being 4-annulate he places in *Philaemon*. Moore (1938) completely describes a 4-annulate land-leech, *Tritetrabdella*, which however has 3 jaws, so demonstrating the dangerous simplicity of Blanchard's systematics. Johansson (1924) described *Philaemon skottsbergi*, a 2-jawed 4-annulate which Ringuet (1955) studied intimately and placed in a new genus, *Nesophilaemon*. Soos (1967) in his highly valuable key to the genera and catalogue of the species of land-leeches provides assistance to those concerned with the difficulties of the 4-annulate leeches. Against this background and with a growing personal experience of the Australian 4-annulates, it is now possible to make progress toward a further understanding of this group.

From Lambert, Ingram and my personal material, the g. *Philaemon* based on *P. pungens* can be characterised with the somital limits of Moore as: 2-jawed; monostichodont with minute teeth (50 to 70); no salivary papillae; 4-annulate; vii, 3-annulate; 2 annuli between vii a_2 and viii a_2 ; viii to xxiii complete (total 16), with $a_1/a_2/b_5/b_6$; xxiv, uniannulate; 6 annuli posterior to xxiii a_2 ; auricles bilobate margined by 3 annuli; crop compartmented, each compartment with a single pair of simple caeca, those of xix forming postcaeca; lambertian organs present, anterior, in xx and xxi, the ducts elongate, 2 or 3 times the length of the organs; genital pores xi b_5 (? b_5/b_6) and xii b_5 (? b_5/b_6); reproductive system, haemadipsoid; no ejaculatory bulbs; ovaries sac-like. Size moderate. Colour pattern, interrupted longitudinal stripes. Terrestrial. Sanguivorous. Australian Region.

A query is provided here on the position of the genital pores because among the continental Australian 4-annulates there are species with the pores close to the posterior border of b_5 even in b_5/b_6 . These appear to belong to *Philaemon* as above.

Soos (1967) differentiates *Philaemon* from *Nesophilaemon* by the absence of lambertian organs in the latter which has an annulation of complete somites as $b_1 = b_2 = a_2 < a_3$. He gives the annulation of *Philaemon* as $b_1 = b_2 = a_2 = a_3$.

In all the 2-jawed 4-annulates from continental Australia which I have personally examined, the annulation of the complete somite is always a_1, a_2, b_5, b_6 as Moore (1938) gives for the 3-jawed *Tritetrabdella*. In my material the somital sense organs are obvious. Somite v is 2-annulate above; vi, 3-annulate above, with two annuli between vi a_2 and vii a_2 ; two annuli between vii a_2 and viii a_2 ; and three annuli between viii a_2 and ix a_2 . To provide a 4-annulate viii having an annulation of $b_1/b_2/a_2/a_3$ with vii 3-annulate as usual, it would be necessary for there to be three annuli between vii a_2 and viii a_2 .

This is not the case in the continental Australian 4-annulates I have so far studied. Since the annulation of complete somites is $a_1/a_2/b_5/b_6$ in 4-annulates where vii is clearly 3-annulate with only two annuli between vii a_2 and viii a_2 , the development of a third annulus in this region can come only through subdivision of vii a_2 so converting vii to the complete condition, as in *Tritetradella* where Moore found vii to be complete, and also in the leech tentatively assigned to *Philaemon grandidieri* by Mann and Tyler (1963), a leech found subcutaneously in a frog in New Guinea. (I have recently had the opportunity of examining this leech. It has 3 annuli between vii a_2 and viii a_2).

The one established exception to this pattern of annulation in the 4-annulates is *Nesophilaemon*, as described by Ringuélet (1955).

The species of *Philaemon* as given by Blanchard (1917) are *pungens* of south-eastern Australia up to the Queensland border, and Java; *P. minutus*, of the Samoan Islands; and *P. grandidieri* of Madagascar. Blanchard gives external meristic data with the somital limits of Whitman. Somital sense organs are shown in all somites figured for *pungens*; on the genital and pregenital region for *grandidieri*; but not in *minutus* in which some nephropores are indicated. From this, the annulations can be converted to the limits of the somites in the manner of Moore.

Blanchard's account of *P. pungens* in the text, he states, is based on specimens from the vicinity of Melbourne, and the description in the text agrees with the *pungens* of Lambert. The specimen illustrated in his Fig. 7 as being *P. pungens*, has vii 3-annulate, only two annuli between vii a_2 and viii a_2 , so complete somites will be $a_1/a_2/b_5/b_6$; viii to xxii are complete (total 15); xxiii, incomplete 4-annulate, $a_1/a_2/(b_5+b_6)$; xxiv, 2-annulate with (?) a_2a_2 forming the anterior lobe of the auricle, a condition not in *pungens*. The genital pores are at xi b_5/b_6 and xii a_2/b_5 , again not as in *pungens*. There are 7 annuli behind xxiii a_2 .

In my collections of 4-annulates ranging from Tasmania to the Iron Bark Range, Northern Queensland, the male pore is reasonably constant in xi b_5 or b_5/b_6 . The female pore is in xii a_1 ; xii b_5 (b_5/b_6); xii b_6 ; or xiii a_1 . I have not yet established the systematic value of the various positions of the genital pore. It is at least specific, and more probably generic in three groups, xii a_1 ; xii $b_5(b_5/b_6)$, b_6 ; and xiii a_1 .

From the above, it can be recognised that the leech shown in Blanchard's Fig. 7 is not *P. pungens*. The figure may possibly be based on his specimens from the Upper Richmond River, northern N.S.W., this being by far the largest specimen available to him. I have not yet seen the leech shown in Blanchard, Fig. 7.

In Fig. 9, *P. grandidieri*, as determined by the somital sense organs, there are two annuli between vi a_2 and vii a_2 ; three annuli between vii a_2 and viii a_2 . In Fig. 8, *minutus*, the indicated position of nephropores permits recognition of annulus 14 as being viii a_2 . The 5th pair of eyes in annulus 7 establishes this as vi a_2 . Accordingly in both species there are 6 annuli between vi a_2 and viii a_2 , as in *Nesophilaemon* and *Tritetradella*, not 5 as in all 4-annulates of continental Australia which I have so far examined. There is no basis in either figure to determine vii as 3- or 4-annulate. If vii is 3-annulate, then viii must be $b_1/b_2/a_2/a_3$ and also the following complete somites. The annulation of complete somites will then exclude both species from *Philaemon*. If vii is 4-annulate, the annulation will be $a_1/a_2/b_5/b_6$ as in *Philaemon*, but vii to xxiii will be complete (total 17). This too excludes both species from *Philaemon*. In *minutus* there are 6, in *grandidieri* 7 annuli behind xxiii a_2 .

It can be noted in Fig. 8, *minutus*, there has been either a simple error, or there is distinctive novelty in the arrangement of the nephropores in this species. The figure shows the '2nd' nephropore on annulus 13. This places

it in viii which in haemadipsoids typically lacks a nephropore. If in fact the 2nd, the '16th' shown on xxiii is actually the 17th and there will be no auricular nephropore. It is possible that *minutus* lacks a labial nephropore.

The g. *Nesophilaemon*.

From Ringuet's detailed account (1955) of *Nesophilaemon skottsbergi* (Johansson, 1924) of Fernandez Island, the characters are: 2-jawed; vi and vii, 3-annulate; viii to xxiii, 4-annulate, complete (total 16) with $b_1 = b_2 < (b_3 b_4)$; the anus at xxvi/xxvii; 5 pairs of testes; genital pores at xi/xii and xii/xiii; auriculate; the auricles margined by 3 annuli; nephropores on viii to xxii, (? labial), and auricular.

It differs from all other 4-annulates in having the annulation of complete somites as a_1 divided into b_1 and b_2 .

Otherwise, it differs in the nature of the reproductive system from all haemadipsoids as known. Ringuet in his other carefully conducted studies of leeches has shown the morphological relationships of the testes and vas deferens correctly, with the testes medial to the vas deferens as in all hirudinoids known to me (Richardson, 1969) and all haemadipsoids where the testes are in the median longitudinal chamber of the body-cavity, connecting laterally through the paramedian palisade to the vas deferens which runs in the paramedian chamber.

Accordingly in his figure, the position of the testes lateral to the vas deferens (and so also in the 3-annulate S. American land-leech *Mesobdella*, Ringuet, 1943) represents a unique morphological relationship among all jawed sanguivorous leeches so far known.

The anterior portion of the paired male ducts in *Nesophilaemon* do not extend into a posteriorly directed simple primary loop as in all known haemadipsoids, but like the Australian aquatic richardsonianid sanguivores the epididymis elaborates in xii posterior to the sperm duct in the contiguous portions of xi and xii, accordingly in a linear relationship unique among the haemadipsoids. There is no ejaculatory bulb.

The male median region appears amyomeric, micromorphic as usual in the haemadipsoids.

The ovaries are sac-like, the oviducts twice the length of the ovaries, and joining without an obvious atrium. The female median region forms on a posteriorly directed simple primary loop. The recurrent limb is shown as little wider than the paired oviduct (as in the young haemadipsoid) and terminates before the elbow of the primary loop so that it is shorter than the procurent limb. It enters terminally (as in the acaecate hirudinoid) into a rapidly widening chamber (Ringuet's 'vaginal sac') which in the contiguous portions of xv and xvi curves sharply to be continuous with the much larger, wider, 'vaginal duct'. There is nothing here of the organization of structures on the female median region typical of the haemadipsoids.

In the above it is clear that *Nesophilaemon* stands apart from the haemadipsoids in the morphological relationships and organization of structures on the anterior portion of the male paired ducts, as also the regional morphology of testes and vasa deferentia; in the organization of the female median region; and in the annulation of complete somites.

The differences are more than simply generic in value. Regrettably, I cannot reach an adequate appreciation of the median female region in *Mesobdella*. Both *Mesobdella* and *Nesophilaemon* appear to be haemadipsoid principally in the annulation of the ocular somites.

***Neoterrabdella*, n.g.**

Monostichodont; duognathous; no salivary papillae; teeth, minute, acute, 25 to 30; annulation of ocular somites, haemadipsoid; vii, 3-annulate; complete somites 4-annulate ($a_1/a_2/b_3/b_4$), viii to xxiii (total 16); xxiv, 3-annulate;

somital sense organs obvious; auricles margined by 6 (or 7) annuli (xxiv a₁ to xxvii); anus at posterior margin of xxvii; salivary glands obvious, loosely arranged in clusters along a few long ducts on each side; pharynx moderately muscular, suspended by obvious radial muscles, terminates viii b₆/b₈; pharynx with a single dorsomedian and paired ventrolateral muscular ridges, the former ending on the margin of the entrance to the pharynx, the paired ridges fusing each to enter a jaw; crop with 11 compartments, each with a single pair of simple caeca, those of xix forming postcaeca; no lambertian organs; intestine with an anterior pair of long caeca each opening lengthwise into the intestine; genital pores, xi b₆ and xii b₆; reproductive system haemadipsoid; 10 pairs of testes; anterior portion of paired male ducts reflect each in a simple loop in the median chamber with the epididymis and sperm duct subparallel; small ejaculatory bulbs present; male median region amyomeric, micromorphic; penis minute, low conical; ovaries, tubular; oviducts short; female median region myomeric, mesomorphic, formed on a simple posteriorly directed loop; recurrent limb, moderately muscular, lumen reduced; procurent limb, strongly muscular, lumen very small; glandular thin-walled oviducal sac present. Size medium. Colour pattern, longitudinally striped, essentially uninterrupted. Terrestrial. Sanguivorous. Australian Region.

Type species: *Neoterrabdella australis* n. sp.; Holotype-specimen deposited in the Australian Museum, Sydney, N.S.W. Coll. No. W 4191. The type specimen has xxv, uniannulate. Collected, 3/12/68, by J. and S. Aldrick and J. Goode, Holmes' Jungle, 10 miles south-east from Darwin, Northern Territory. On coarse bladed grass a foot and more above the ground.

(The generic name is based on: *neos*, new; *terra*, land; and *bdella*, leech. f.).

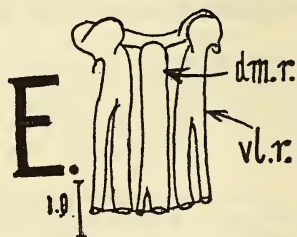
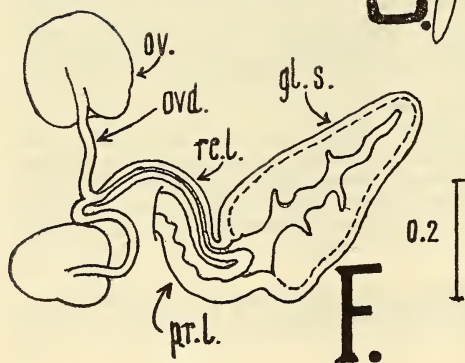
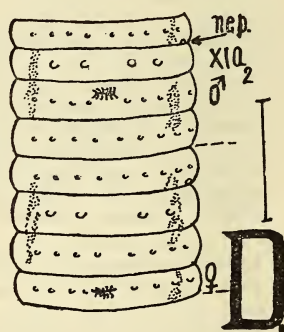
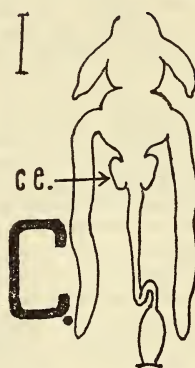
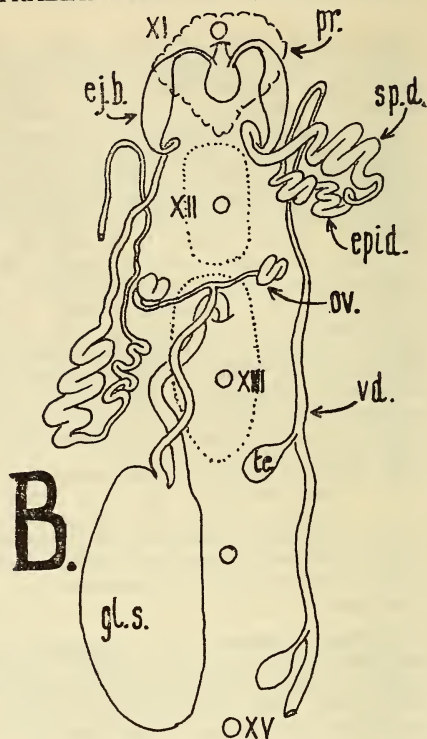
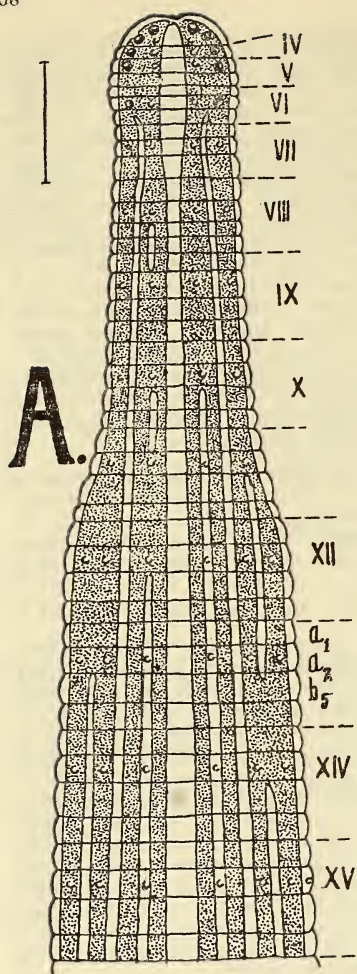
Being 4-annulate on complete somites, *Neoterrabdella* is comparable with *Nesophilaemon*, *Philaemon* s.s., the '*Philaemon*' of *grandidieri* and *minutus*, and *Tritetrabdella*. It resembles *Nesophilaemon* only in that both are 2-jawed and lack lambertian organs, the two differing in the pattern of annulation of complete somites, in the regional morphology of the male paired ducts, the relationships of the organs on the anterior portions of the male paired ducts, and in the organization of the female median region which is peculiar to *Nesophilaemon* and typically haemadipsoid in *Neoterrabdella*. *Neoterrabdella* has ejaculatory bulbs, lacking in *Philaemon* s.s., and lacks the lambertian organs which are present in *Philaemon* s.s. (as also in the 5-annulate *Chthonobdella*, a second Australian 5-annulate genus, and the 6-annulate *Phytobdella*—all of which are 2-jawed). The 3-jawed *Tritetrabdella* also lacks lambertian organs, and has 3 annuli between vii a₂ and viii a₂, vii being 4-annulate (which is probably also the actual condition in '*Philaemon*' *grandidieri* and *minutus*, and so differs from *Neoterrabdella* in which vii is clearly 3-annulate, and vii a₂ is followed by only 2 annuli).

With increasing knowledge of the Australian 2-jawed land-leeches, all known until now as having lambertian organs, it seemed most probable that these represent a familial group distinct from the F. Haemadipsidae. *Neoterrabdella* does not fall fully within the concept formulating for the Australian family, and for the time being can only be referred provisionally to the F. Haemadipsidae s.l., differing from all auriculates in having the auricles margined by 6 or 7 annuli.

***Neoterrabdella australis*, n.sp. (Fig. 1A to E, 2G, H)**

A medium sized, strongly papillate, richly coloured land-leech with seven delicate dorsal longitudinal stripes. The venter immaculate, pale pinkish red in life. The dorsum with a background colour of dark blackish brown in life with seven well-defined longitudinal narrow golden-yellow stripes which are finely black-margined in full extension. The background fades in alcohol to pale reddish brown, the stripes to pale creamish yellow or cream with very narrow nearly black margins.

The longitudinal dark bands between the stripes are of equal width in the middle half of the body where the paired stripes are of about half the width of the dark bands.



The median light stripe is under half the width of the median field and continuous from the first pair of eyes to the anus, but does not extend onto the posterior sucker which is plain, immaculate, and light in colour on the dorsum. The median stripe narrows anteriorly back to ix, widening a little to continue of this width to xvii, narrower behind this to xx and briefly wider back to xxvii. The paired light stripes are each about half the width of the median. The innermost pair are paramedian, include the sense organs, and extend continuously or only briefly interrupted from xxiv a₂ to ix a₂, or only to xii/xiii being represented anterior to this by elongate patches as between xi a₂ and x a₂, and ix a₂ to viii a₂, but never represented anterior to viii a₂, so that the paramedian stripes are always shorter than the median and the adjacent paired stripes lateral to them. This second pair of stripes are each median in the paramedian field and continuous from xxiv a₂ to vi a₂/a₃, terminating just medial to and just behind the 5th pair of eyes. The third pair of stripes are in the intermediate field, for the greater part of their length slightly wider than the paramedian stripes, and extend from xxiv a₂ to xi b₅ either continuously or with brief interruptions as from xvii a₂/b₅ to ix a₂/b₅, or xiii a₂ to xiv a₂, and do not extend anterior to xi a₂. A fourth and wider pair of light stripes are of the colour of the venter, marginal in position, and extend from the posterior border of the auricle to iii/iv being lateral anteriorly to the eyes. These stripes are partially, even incompletely separated from the venter by one or two rows of diffuse, irregular, small, dark elongate or short patches of such size and frequency as to suggest in places the presence of an interrupted line separating the marginal stripe from the venter; but not in all specimens.

A second collection (9/2/69) from the same location contains 17 specimens ranging from 10.0 to 44.0 mm. in length. A specimen 10.0 mm. long lacks pigment other than in the eyes and very small, closely spaced pale brown indistinct specks in a transverse row on all annuli and of such number as to be apparently associated with the secondary sensillae. Otherwise, it is translucent, pale flesh pink, and entirely without stripes and bands. A slightly longer specimen, 12.5 mm., is pale greyish black on the dorsum and venter, the dorsum divided into three pairs of pale dark bands by a median and two pairs of uninterrupted faint lighter stripes corresponding to the stripes of the paramedian lines and the stripes of the paramedian fields. These terminate at xxiii/xxiv, the inner extending to x a₂, the outer to vi/vii. Another of this same size is much darker in general, almost a pale black, with pale stripes and dark bands as in the adult, i.e. the stripes in the intermediate fields have been added. The adult colour appears in specimens 15.0 mm.

Figure 1. A to E, *Neoterrabdelta australis*, n.g., n.sp. A. Somites 1 to xv, dorsal aspect to show colour pattern in relation to somital sense organs; B. Reproductive system, dissection from the dorsal aspect, primary loops of male paired ducts displaced laterally and the medial aspect shown, dotted lines indicate the normal position of the organs on the male primary loops; C. Posterior portion of crop and the intestine showing location and form of the intestinal caeca; D. The location of the genital apertures and the ventrolateral bands; E. Pharynx opened along midventral line to show internal muscular ridges; F. *Chthonobdella limbata*. In toto cleared preparation of the female reproductive system of a 13.0 mm. long specimen showing the relationships of the two limbs and the glandular sac, and the reduced lumen of the thick-walled recurrent limb.

Somites and somital ganglia in Roman figures. ce., intestinal caecum; dm.r., dorsomedian muscular ridge; ej.b., ejaculatory bulb; epid., epididymis, gl.s., glandular sac; nep., nephropore; ov., ovary; ovd., oviduct; pr., prostate; pr.l., procurent limb; re.l., recurrent limb; sp.d., sperm duct; te., testis; v.d., vas deferens; vl.r., ventrolateral ridge. All scales in mm., 2.0 mm. unless otherwise indicated.

long and longer. The sequence in development of pattern and colour is apparently that described by Ingram (1957) for *P. pungens* which at hatching is some 5.0 mm. in length, uniform dark brown and without pattern. The pattern became evident at 3 months when her leeches had grown to 6.0 mm. and could extend to 15.0 mm.

A specimen 25.0 mm. long in full contraction, reached 55.0 mm. in full extension. At rest the anterior end is broad, low convex, continuous with the short heavy pregenital region which widens rapidly and progressively so that the body is generally heavy and broad in appearance, convex above, and wider than the posterior sucker. In extension the leech shows a distinct anterior sucker set off from the narrower cylindrical neck and an elongate cylindrical body narrower than the diameter of the posterior sucker. In life, the margin of the posterior sucker is clearly even though minutely scalloped, each such a minute convexity at the end of a radial band on the ventral face of the sucker which from time to time shows a well-formed and large clamp.

Annulation:

Somital and secondary sensillae and the lateral nephropores are clearly obvious. Interannular and intersomital furrows are equivalent and there was nothing persistent or regular in the way of couplets, triplets, or individually defined somites. All annuli are divided into areolae which carry somital sense

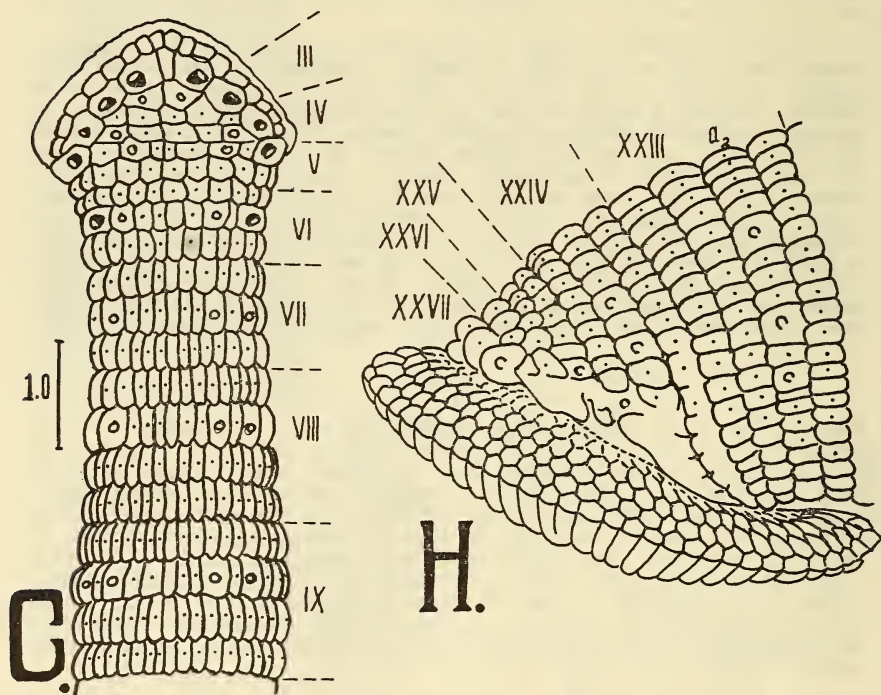


Figure 2. *Neoterrabdella australis*, n.g., n.sp. G. Dorsal view of velum, anterior sucker and pregenital region to somite ix; H. Right lateral aspect somites xxiii to xxvii of a specimen with xxv 2-annulate, showing auricle, dorsal and margin of ventral surface of posterior sucker.

organs and sensillae on the a_2 annuli and sensillae only on other annuli. The areolae are thrown into high convex papillae in contraction.

The velum is short, thick and thick margined, formed by i, ii, iii, and iv which are transversely tessellated and bordered by the narrow clear margin of the velum. Somite ii carries the 1st pair of eyes; iii, the 2nd pair with the first pair of paramedian somital sense organs between the eyes; iv, 2-annulate between the eyes with the paramedians in the posterior annulus but there is no indication of subdivision of either of the areolae carrying the 3rd pair of eyes. Somite v is 2-annulate above, with the 4th pair of eyes in $a_1a_2 > a_3$, and uniannulate below where it forms the lateral and ventral margins of the sucker; vi, 3-annulate above with $a_1 < a_2 < a_3$, the 5th pair of eyes in a_2 , and 2-annulate below; vii, fully 3-annulate with $a_1 < a_2 < a_3$, and in one specimen with the intermediate sense organs pigmented and eye-like in all respects; viii, 4-annulate with $a_1 = a_2 > b_5 = b_6$. Somite ix carries the first of the laterally situated nephropores on the posterior portion of a_1 , and is 4-annulate. Somite xxiii is the last 4-annulate somite, carries the last of the laterally situated nephropores, so that there is a total of 16 complete somites. In ix to xiii, $a_1 < a_2 < b_5 > b_6$; xiv to xx, $a_1 < a_2 = b_5 > b_6$; xxi to xxiii, $a_1 = a_2 = b_5 > b_6$. There is some difficulty in determining the relative lengths of the annuli in ix to xxiii, a_1 being nearly equal to a_2 and appearing either slightly longer or shorter than it; a_2 is commonly nearly equal to b_5 , but b_5 is constantly and obviously larger than b_6 throughout the greater number of the complete somites. Somite xxiv is 3-annulate with $a_1 = a_2 > a_3$. Somite xxv, characteristically uniannulate in the land-leeches, is uniannulate in 3 specimens but definitely 2-annulate in 2 specimens with a_1a_2 carrying well-marked intermediate sense organs and $a_1a_2 > a_3$. Somites xxvi and xxvii are uniannulate. The anus is at the posterior margin of xxvii. There are 8 or 9 annuli posterior to xxiii a_2 .

The auricles are large and prominent, obvious, and formed along the lateral margins of xxiv a_2 to xxvii; xxiv a_1 is incompletely areolated along the lateral portion which lies anterior to the auricle. Accordingly the auricle is margined by 6 or 7 annuli depending on whether xxv is undivided or divided into 2 annuli. The annuli between the auricles are transversely abbreviated, xxiv a_1 being the last annulus complete on the venter.

The dorsum of the sucker is areolate in 4 concentric rows, shows only one pair of paramedians, and the marginal areolae or tessellations match to the radial bands on the ventral surface of the sucker, which are in the order of 64 in number. The clamp is large and includes about 12 radial bands.

Alimentary tract.

The pharynx contains a single median dorsal muscular ridge which terminates anteriorly in a small barely elevated transverse short pad, and two pairs of ventrolateral ridges which each fuse to a single ridge before entering the jaw. The jaws are low, moderately compressed, the dental edge long, low convex, and for the greater part the jaws are retractable into open pockets. There is a single row of closely approximated minute sharp teeth on each jaw. These as seen in the chitin withdrawn from the sucker cavity, total 23 to 28, are broad based with an erect sharp-tipped cylindroid median portion. A large tooth is no more than 8.0 μ m. tall.

The pharynx terminates at viii b_5/b_6 and is suspended by obvious radial muscles which extend also back into x. The salivary glands are very obvious as many large gland cells packed in irregular clusters along a few, possibly 3 or 4 main ducts on each side, extending back into x, and nowhere forming compact adherent masses. The crop consists of 11 compartments in ix to xix each with a single pair of simple lateral caeca which increase in size posteriorly and from xiii extend posteriorly into the following somite. Those of xix form the postcaeca which reach into xxiv.

There is no indication of lambertian organs. The postcaeca end simply and bluntly.

The intestine commences at xix/xx, initially of the width of the postcaecum and with a prominent pair of lateral caeca which are low, of the length of a somite, and open freely lengthwise into the intestine. These in position and form present the appearance of lambertian organs, but their nature as lateral intestinal caeca is shown in the free movement of the intestinal contents into and out of these structures. Posterior to xxi, the intestine tapers, is thrown into a single 'S' loop before joining the short and wider rectum.

Reproductive system.

This is haemadiploid in general organisation and in regional morphology. The genital pores open at xi b_5 and xii b_6 , the male pore in the anterior half of b_5 , a_2/b_5 , a_2 ; the female pore median in b_6 .

There are 10 pairs of simple sac-like testes in the median chamber in xxii/xxiii to xiii/xiv, each connecting by a short vas efferens to the vasa deferentia in the paramedian chamber. The left vas deferens enters the median chamber at xi/xii, the right at xi b_5/b_6 , and each extends posteriorly as a simple primary loop within the median longitudinal chamber, the initial limb being recurrent, the terminal limb, procurent. The recurrent limb of the loop on the left male duct consists of a length of vas deferens which elaborates as epididymis at xii/xiii continuing to xiii/xiv where the recurrent limb commences as a compactly coiling thin-walled sperm duct which becomes a simple straight sperm duct running from about xii b_5/b_6 to the small but definitely strongly muscular ejaculatory bulb in xi, so that the greater length of both limbs of this loop are vas deferens and straight sperm duct extending from the posterior annuli of xii, into xi. The loop on the right male duct is short, extending back to about xii b_5 . The recurrent limb is very briefly vas deferens and then epididymis, and the terminal procurent limb is, almost entirely compactly coiling thin-walled sperm duct. In this way, the elaborated loops lie with the right anterior to the left in the median chamber, and the elaborated portion of the left loop extends back to be dorsal to the median region of the female system, and all completely ventral to the crop. The minute ejaculatory bulbs are entirely within xi, similar in form and size, lack defined cornua, and continue by very short non-muscular delicate ducts which enter independently low on the anterior face of the male atrium. This atrium is micromorphic, small, weakly muscled, entirely ventral to the nerve cord, but standing above the muscular layers of the body-wall envelope.

The single pair of ovaries are elongate, tubular, briefly folded on themselves, and situated in the posterior two annuli of xii. The delicate thin-walled oviducts are short, of the length of the ovaries and join in xii to the median region with no indication of a formed atrium.

The female median region has the form of a posteriorly directed loop with an expanded sac formed from the posterior face of the loop.

The recurrent limb is narrow, but one half the width of the procurent limb, weakly but definitely muscular although not showing a strongly organised circular layer. The lumen is relatively narrow. The wall thick. It enters the anterior face of the sac immediately adjacent to the end of the procurent limb which is thick walled, strongly muscular with an obvious layer of circular muscle, a very reduced lumen. It passes directly to the bursa.

The wall of the sac is thinly muscular, without indications of any strongly organised muscle layers, and glandular in texture internally. The limbs open into it and from it without any indication of sphincter or other valves. The anterior wall of the sac is thickened and somewhat more muscular in an area around the connections of the limbs.

The prostate is diffuse, extensive, covering the atrium, the anterior ends of the ejaculatory bulbs and extending posteriorly between them.

There is no indication of albumen glands in these specimens.

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